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(12) **United States Patent**  
**Rey et al.**

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(54) **VARIABLE AREA NOZZLE FOR GAS TURBINE ENGINES DRIVEN BY SHAPE MEMORY ALLOY ACTUATORS**

(58) **Field of Search** ..... 60/226.1, 226.3, 60/271; 239/265.19, 265.33

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(57) **ABSTRACT**

(\*) **Notice:** Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

A gas turbine engine includes a variable area nozzle having a plurality of flaps. The flaps are actuated by a plurality of actuating mechanisms driven by shape memory alloy (SMA) actuators to vary fan exit nozzle area. The SMA actuator has a deformed shape in its martensitic state and a parent shape in its austenitic state. The SMA actuator is heated to transform from martensitic state to austenitic state generating a force output to actuate the flaps. The variable area nozzle also includes a plurality of return mechanisms deforming the SMA actuator when the SMA actuator is in its martensitic state.

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(52) **U.S. Cl.** ..... **60/226.3**; 60/226.1; 60/271; 239/265.19; 239/265.33

**19 Claims, 8 Drawing Sheets**

